



Beyond the Algorithm: A Perspective on Tackling Bias and Cultural Sensitivity in AI-Guided Aesthetic Standards for Cosmetic Surgery in the Middle East and North Africa (MENA) Region

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rather than enhancing individualized care. Ensuring that AI serves to support, not homogenize, the region's rich aesthetic traditions is both an ethical and clinical imperative.

This perspective article synthesizes existing evidence to: (1) examine algorithmic bias in aesthetic AI systems affecting MENA populations, (2) analyze the cultural implications of Western-centric AI applications, and (3) propose a practical framework for culturally sensitive AI implementation in aesthetic medicine. Our analysis provides actionable recommendations for technology developers, healthcare providers, and policymakers to ensure AI tools respect and enhance the region's diverse aesthetic traditions. The proposed framework focuses on redesigning algorithms to incorporate regionally representative data, establishing cultural competency standards for AI evaluation, and fostering close collaboration with MENA healthcare professionals to ensure that AI-driven recommendations reflect the region's diverse aesthetic values.

The Rise of AI in Aesthetic Medicine

Artificial intelligence (AI) is emerging as a powerful tool for standardizing and enhancing aesthetic evaluations in cosmetic medicine. Traditionally, plastic surgeons have relied on subjective clinical judgment and culturally informed training to assess facial features. AI now offers the potential to reduce inter-practitioner variability by providing data-driven, algorithmically derived assessments. A notable advancement in this domain is the development of the Facial Aesthetic Index (FAI), an algorithmic tool designed to analyze facial attributes and propose cosmetic enhancements based on quantified metrics.³ These systems utilize large-scale image datasets to assess characteristics such as facial symmetry, proportions, skin texture, and signs of aging, ultimately generating "objective" beauty scores and individualized treatment recommendations.

Initial perspectives within the aesthetic medicine community have been largely optimistic. In a 2024 global consensus panel of aesthetic experts, 100% of participants agreed that AI could enhance standardization in patient evaluations, assist in surgical planning, and mitigate risks such as overcorrection.⁴ This has driven efforts to establish validated indices that quantitatively assess facial attractiveness and aging, serving as adjuncts to human clinical expertise.

The scope of AI applications in aesthetic and reconstructive surgery has expanded rapidly, encompassing surgical planning, outcome prediction, and patient assessment across a range of subspecialties.^{5–9} These advancements are poised to fundamentally reshape clinical approaches, offering new levels of precision and consistency in cosmetic care.

Despite the promise of AI, caution has been strongly advised. Aesthetic perception is not solely grounded in anatomical proportions; it is deeply shaped by cultural norms, individual identity, and sociopolitical context.¹⁰ Features flagged as "flaws" by an algorithm may, in fact, represent valued ethnic or cultural traits. Accordingly, there is growing consensus that AI systems used in aesthetic evaluation must integrate considerations of patients' ancestry and cultural backgrounds. The aforementioned expert panel explicitly recommended that "patients' ancestral roots should be included in the AI system" to ensure culturally appropriate evaluations.⁴

This call for culturally responsive AI arises amid increasing awareness of algorithmic bias, systematic errors that disproportionately affect certain demographic groups. In the context of cosmetic surgery, such biases can perpetuate narrow beauty ideals and misrepresent diverse populations. As AI continues to gain traction in aesthetic medicine, there is an urgent need to critically examine how these biases manifest, particularly in culturally heterogeneous regions such as the MENA.

Algorithmic Bias in Beauty AI Systems

Algorithmic bias arises when AI models systematically disadvantage or privilege specific demographic groups due to skewed training data or flawed model design. This phenomenon is well documented in facial-analysis research. In a seminal study, Buolamwini and Gebru reported that commercial gender-classification algorithms misclassified darker-skinned women far more frequently than lighter-skinned men, a disparity directly attributable to imbalanced training datasets.¹¹ Early face-image corpora frequently contained more than 80% light-skinned individuals of European ancestry, leaving algorithms ill equipped to generalize to other phenotypes.

Subsequent efforts have aimed to correct these imbalances. The creators of the FairFace dataset, for example, constructed a race-balanced image repository with approximately equal representation across seven racial groups, explicitly including

particular challenges in patient consultation and outcome visualization. When MENA patients use AI-powered visualization tools to preview potential surgical results, they may be shown outcomes that reflect Western rather than culturally appropriate aesthetic goals. For instance, a Palestinian woman seeking rhinoplasty might be shown visualization results featuring narrow, upturned noses typical of European aesthetics rather than refined versions of the strong, dignified nasal profiles valued in her cultural context. This misrepresentation can lead to unrealistic expectations and procedures that ultimately diminish rather than enhance the patient's ethnic identity. These biases mirror prevailing stereotypes within the beauty industry and, if left unaddressed, risk perpetuating a restrictive aesthetic standard that marginalizes significant portions of the population.

Why These Biases Matter in Cosmetic Surgery

Unlike biases in web searches or product recommendations, biased aesthetic algorithms have a direct impact on individuals' bodies and identities. When AI-driven "beauty score" systems or cosmetic outcome simulators are primarily calibrated on Western norms, patients from regions such as the Middle East and North Africa (MENA) region may receive misleading or culturally incongruent feedback, for example, suggestions that naturally broader noses or darker skin tones are less attractive according to the algorithm.

Such feedback risks encouraging patients to pursue unnecessary or excessively aggressive procedures aimed at "correcting" features that are, in fact, normal and culturally valued within their communities. Moreover, it can undermine self-esteem by implicitly framing certain ethnic characteristics as undesirable. This phenomenon represents a subtle yet pervasive form of digital neo-colonialism (the imposition of foreign cultural values and standards through technological systems, perpetuating power imbalances in the digital age), where AI functions as a unidirectional force imposing foreign beauty ideals onto local cosmetic practices.

Cultural Differences Aesthetic Ideals in the MENA Region

Extensive research has demonstrated that perceptions of beauty are deeply influenced by cultural context, challenging the validity of any singular, universal aesthetic standard. A seminal cross-cultural study by Broer et al surveyed both plastic surgeons and laypeople from over 50 countries, including populations from the Middle East, regarding ideal facial proportions.¹⁹ The study concluded that perceptions of facial attractiveness are strongly shaped by cultural and ethnic backgrounds and cannot be accurately defined by fixed numeric ratios or so-called "divine proportions".

Regional Beauty Preferences

Communities within the Middle East and North Africa (MENA) region possess distinct aesthetic ideals shaped by a rich tapestry of cultural influences, including Persian, Arab, Turkish, and Amazigh traditions. These ideals often emphasize harmony with one's natural features rather than adherence to Western standards such as facial symmetry or youthfulness. For instance, patients of Middle Eastern descent may seek rhinoplasty to reduce a dorsal hump while preserving a strong and dignified nasal profile, an aesthetic preference that contrasts with the smaller, upturned nose commonly portrayed in Western media.

A recent study by Arian et al offered comprehensive evidence of such cultural variation in aesthetic preferences across facial, breast, and gluteal features.²⁰ The authors reported that commonly cited facial "golden ratios" are inadequate for representing attractiveness standards among diverse ethnic groups. The majority of studies reviewed emphasized that aesthetic procedures should aim not to Westernize, but rather to enhance and preserve ethnic identity.

Additional research has further documented specific preferences among Middle Eastern patients, highlighting aesthetic goals that differ markedly from Western norms.^{21,22} These findings reinforce the critical role of cultural context in shaping perceptions of beauty and desired outcomes in cosmetic interventions.

A growing body of literature has also challenged the universality of classical beauty standards, demonstrating that mathematical models such as the golden ratio do not reliably capture attractiveness across different populations.^{23–28} While appealing in their seeming objectivity, such formulas fail to reflect the complex cultural and individual preferences that define beauty across diverse societies.

model accuracy with fairness. However, these approaches come with significant implementation challenges and costs that must be carefully considered.

One approach is multi-objective optimization, which can be employed during model training to simultaneously optimize for predictive accuracy and fairness metrics. This ensures that improving one performance dimension does not come at the expense of equitable outcomes. While promising, this approach requires substantial computational resources and expert technical personnel, potentially increasing development costs significantly compared to traditional AI development.

Another effective method is adversarial training, whereby models are trained not only to make accurate predictions, but also to minimize their ability to infer sensitive attributes such as patient ethnicity. This reduces the likelihood of demographic bias being encoded in the decision-making process. The challenge lies in maintaining system coherence and avoiding contradictory recommendations, which requires careful coordination and ongoing monitoring.

Additionally, ensemble methods offer flexibility by combining outputs from multiple models, each trained on different demographic subsets. These models can be weighted based on patient ethnicity or regional aesthetic preferences, thereby improving personalization while reducing cultural bias. Finally, to maintain fairness over time, continuous monitoring systems should be implemented to track AI recommendation patterns across demographic groups. These systems can issue automated alerts when fairness thresholds are breached. Furthermore, real-time bias detection can help identify systematic disparities, such as disproportionately recommending certain procedures to specific ethnic groups, enabling timely interventions and retraining where necessary. Such monitoring systems require dedicated infrastructure and personnel, representing ongoing operational costs that healthcare institutions must budget for.

Diversify and Localize Training Data

The foundation of any AI model lies in the quality and representativeness of its training dataset. To ensure equitable performance in the MENA context, developers must actively curate training data that reflects the full spectrum of ethnic and phenotypic diversity within the region. This includes sourcing images and aesthetic preference data representative of Arab, Persian, North African, and South Asian populations.

One effective strategy is to establish collaborations with regional clinics to collect anonymized pre- and post-operative photographs, obtained under strict ethical oversight with appropriate consent and privacy safeguards. Such datasets would enable AI systems to learn and respect region-specific aesthetic goals rather than defaulting to externally imposed standards.

While publicly available datasets like FairFace include a “Middle Eastern” category, these classifications often lack the granularity needed to capture intra-regional diversity. The creation of comprehensive, culturally representative datasets requires significant investment in data collection, annotation, and quality assurance processes, with costs potentially reaching hundreds of thousands of dollars for adequately sized datasets.

Inclusion of Cultural Experts

The development of aesthetic AI systems must extend beyond the domain of data science and Western-trained surgical expertise. To ensure cultural relevance and sensitivity, interdisciplinary collaboration is essential, particularly with anthropologists, sociologists, and cosmetic surgeons from the MENA region. These cultural experts can provide critical insights into local conceptions of beauty and help redefine what constitutes a “successful outcome” in ways that go beyond standardized ratios or universal ideals.

Involving such stakeholders early in the design and validation process allows for the identification of cultural blind spots that may otherwise go unnoticed. Their input can guide AI systems to avoid recommendations that conflict with religious values or modesty principles, such as promoting overly dramatic alterations to features that are traditionally celebrated or meant to be subtly enhanced.

Ultimately, cultural competency should be treated with equal importance as technical competency in the teams responsible for building and deploying these systems. The inclusion of diverse voices not only enhances fairness and acceptability but also ensures that AI tools are aligned with the values and expectations of the communities they serve.

govern AI use in healthcare, including regular audits of algorithmic performance across patient subgroups and enforceable penalties for non-compliance.

Next Steps: Innovation and Inclusion in Aesthetic AI

Future researchers should prioritize empirical investigations that translate theoretical frameworks into real-world evidence. Qualitative interviews with MENA cosmetic surgeons could provide critical insights into their lived experiences with AI integration, highlighting practical challenges and adaptive strategies that remain underrepresented in the current literature.

Patient satisfaction studies across diverse ethnic groups using AI-assisted consultations would offer direct assessments of cultural sensitivity and inclusivity from the patient's perspective. Similarly, prospective trials comparing AI-generated recommendations with actual surgical outcomes across MENA populations would help validate the clinical effectiveness of culturally adapted AI systems.

From a technical standpoint, future innovation must focus on developing culturally responsive AI architectures. Approaches such as few-shot learning can improve model performance for underrepresented groups with limited data, while transfer learning techniques could enable AI systems to adapt knowledge from one cultural context to another, enhancing cross-cultural generalizability.

Finally, the creation of comprehensive ethical frameworks is essential to guide the responsible evolution of AI in aesthetic medicine. These frameworks must safeguard patient autonomy and uphold cultural values, ensuring that advancements in efficiency and precision do not come at the cost of inclusivity and respect.

Conclusions

The integration of AI into aesthetic medicine offers exciting possibilities to enhance outcomes and objectivity, but it also highlights a fundamental truth: Beauty cannot be divorced from culture. This is especially true in MENA societies, where standards of attractiveness are shaped by history, geography, and cultural values.

If we allow AI algorithms, often designed and trained far from the region, to dictate what is beautiful or recommend surgical changes without adaptation, we risk a homogenized standard of beauty that marginalizes cultural diversity. The evidence reviewed, from the biased results of Beauty.AI to the skewed outputs of generative AI systems, demonstrates that algorithmic bias is not a theoretical issue; it is already affecting how we see ourselves.

To move beyond algorithms, we must insist that these tools are developed and deployed with deep respect for cultural diversity and individual uniqueness. In practical terms, this means building bias-resistant AI, rooted in representative data and guided by local expertise. It means the surgeons in the MENA should critically appraise any AI-driven recommendations and use them only in tandem with their nuanced understanding of the patient in front of them.

Moving forward, we recommend immediate priorities in three key areas. First, technology developers must establish minimum representation standards, with at least 20% MENA populations in all aesthetic AI training datasets, coupled with real-time bias monitoring systems that alert when demographic disparities exceed acceptable thresholds. Second, healthcare institutions should implement mandatory cultural competency training for practitioners using AI-assisted tools and establish patient feedback systems specifically designed to capture cultural sensitivity concerns. Third, policymakers must develop regulatory frameworks requiring cultural impact assessments for medical AI systems prior to market approval, similar to existing safety and efficacy requirements. These actions, implemented concurrently, can create the foundation for culturally responsive AI deployment across the region.

The path forward can transform a potential pitfall into a strength. If properly built, AI can celebrate various definitions of beauty: imagine AI tools that can show patients how they would look after surgery in a way that aligns with their cultural aesthetics, or algorithms that can highlight examples of attractive faces from the patient's own ethnic group as guides.

With Middle Eastern and North African nations such as the UAE taking global leadership in AI strategy, the region has the opportunity to also lead in ethical, culturally mindful AI in medicine. By investing in this opportunity now, through research, interdisciplinary collaboration, and regulation, we can ensure that the coming era of AI-enhanced cosmetic surgery empowers individuals and honors cultural identity, rather than enforcing uniformity.

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